How to reduce CO2 emissions and Climate Change - Gary Nahrung (Jan. 2021)

I am shocked that so few people know or accept what climate scientists have told us for over 20 years, the long-term climate outlook, or that we could easily improve this situation.

- The Australian atmospheric station, at Cape Grim, began atmospheric gas measurements in 1976. Measured Carbon dioxide levels increased from 335 ppm (1976) to around 411 ppm (2020). 76 ppm in just 44 years, (over 100 ppm increase in CO2 in the last 60 years).
- By the 1970's there was unambiguous evidence of Climate Change (Global Warming) which led to the 1992 Rio Earth Summit and Climate Change Convention (signed by 154 States). Human induced climate change is accepted by over 98% of **all** Climate Scientists.
- This warming will not be uniform. Warming produces changes to ocean currents, rainfall pattens, increased wildfires, melting sea ice, retreating Glaciers, rising sea levels, more frequent extreme weather events, and a rise in mean temperature (minimums, maximums, and extremes). This is best referred to as **'Climate Change', not *Global Warming***.
- We have already measured over 1 degree C rise since 1900 (last 120 years) and sea level rises and increases in the frequency of weather-related events. Measurements show changes to atmospheric gas concentrations, weather cycles, cyclones, the polar vortex, wildlife extinctions, ocean acidification, permafrost thaws and other changes.
- Global temperature rises over 2 degrees Celsius will trigger a range of positive feedback loops which make a rise pass 3 degrees Celsius difficult to avoid (a point of no return).
- These positive feedback loops include the loss of forests, reduced reflectivity of Artic ice (albedo effect) resulting in faster warming of the ocean, massive methane releases from Methane Hydrates, and CO2 from melting permafrost, so temperature rise will speed up.
- Permafrost soils (many of which are rapidly thawing) are estimated to contain around 12,000 to 15,000 gigatons of organic carbon. This is about twice what is currently in the atmosphere and three times as much as is held in all the world's forests.
- CO2 rise is a cumulative effect. New emissions are added to CO2 concentration from all previous year's emissions. The CO2 concentration (and its warming effect) does not go away as soon as we stop adding more. It takes **centuries for CO2 to slowly come out of the atmosphere** and all this time, its warming effects on earth's climate will continue.
- Far from **reducing the rate** CO2 is being added to the atmosphere, the **rate is increasing**
- Australia is among the worst in the world for CO2 emissions on a per capita basis.
- Australia is highly vulnerable to the effects of climate change with the loss of the Great Barrier Reef quite likely. Increased fires, floods, cyclones, and more droughts are certain.
- With a concerted effort, Australia could halve its emissions in less than a decade with minimal impacts to our overall economy and some huge positive outcomes.
- There is no debate among the world's leading climate scientists that this is a man-made problem that will go from extremely serious to catastrophic within the next decade or two. Existing technologies could quickly halve the CO2 emissions but are not being used.
- There are many sources of **reliable information on Climate Change** including the IPCC (**I**ntergovernmental **P**anel on **C**limate **C**hange). The IPCC is tasked with looking at the evidence in an objective, scientific manner. It reviews all available published evidence but does not direct, pay for, or commission any research. It is seen as the most unbiased and reliable authority on Climate change. Reports issued by the IPCC are subjected to a line-by-line review by representatives of all the participating governments (over 120 countries). These reports are freely available to all and can be easily found on the internet.

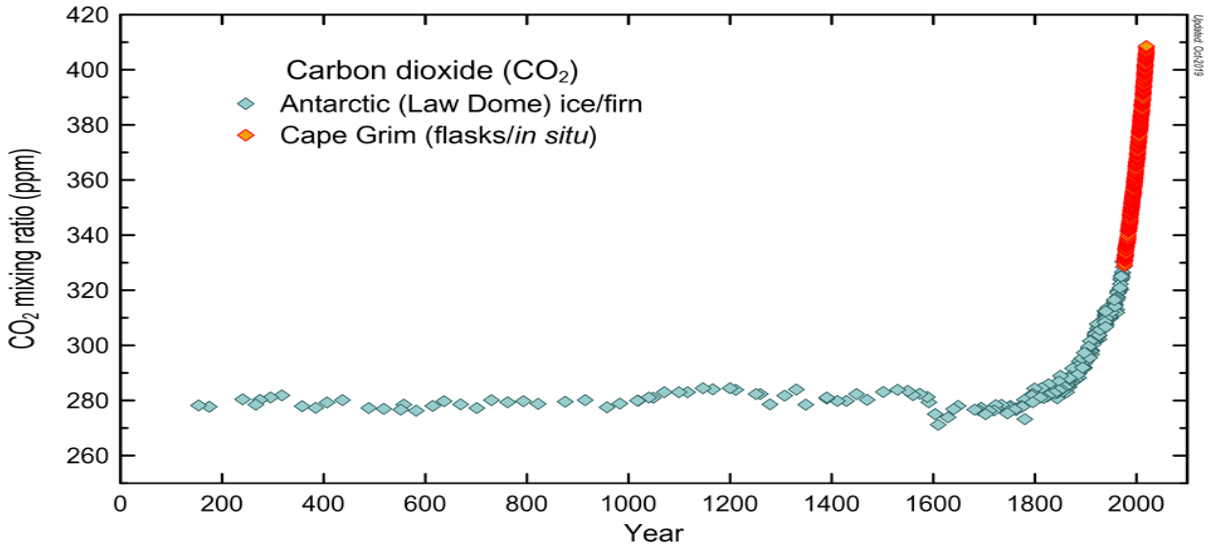
Index for this essay – To help locate particular topics

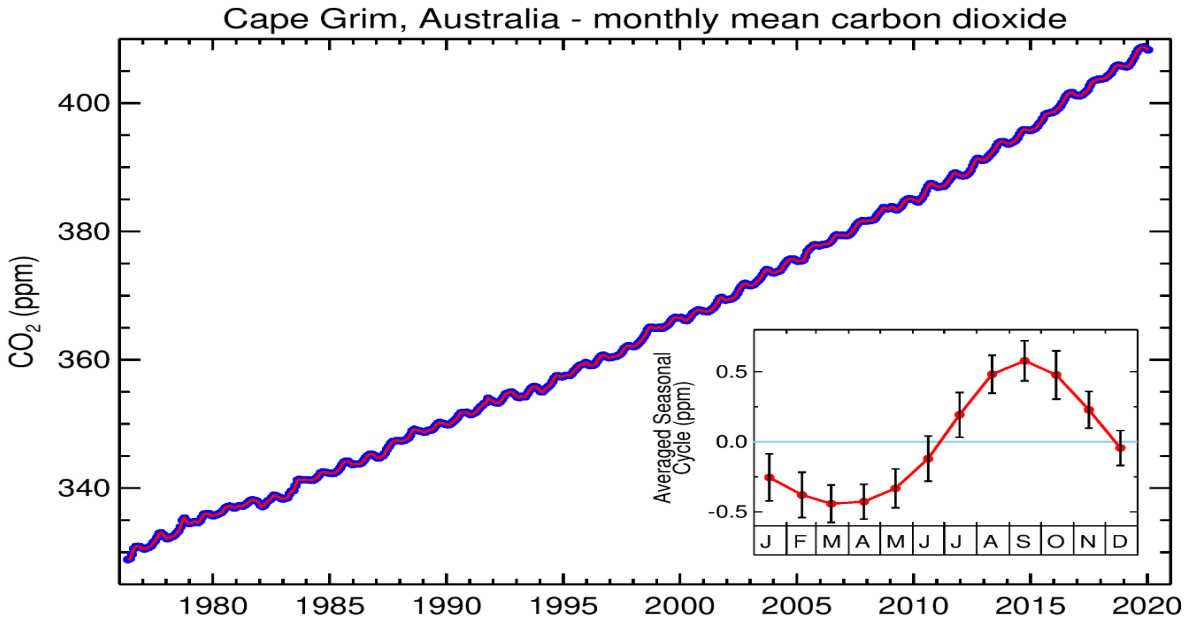
RECENT DEVELOPMENTS - EU Carbon Border Tariffs

Australia's free ride on climate change is set to end, with the European Union taking the first step to introduce a cross border carbon tax. The European Parliament recently gave the nod to move to apply penalty tariffs because we are not taking steps to reduce CO2. This means Australian products entering the EU are likely to be hit by a tariff to make up for the fact Australia has no price on carbon.

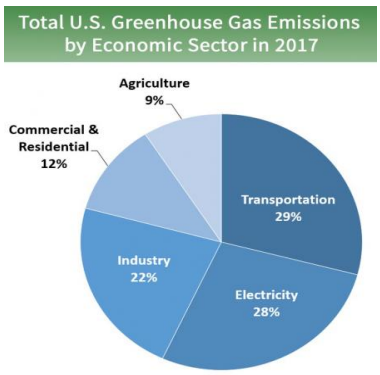
South Australia, Victoria and NSW are all in the process of constructing Grid scale Batteries. Queensland and the Federal Government have not.

CO2 levels over last 2000 years (from Antarctic Ice Cores and Cape Grim)

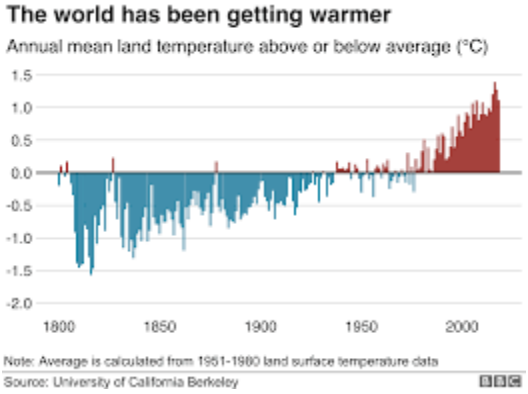


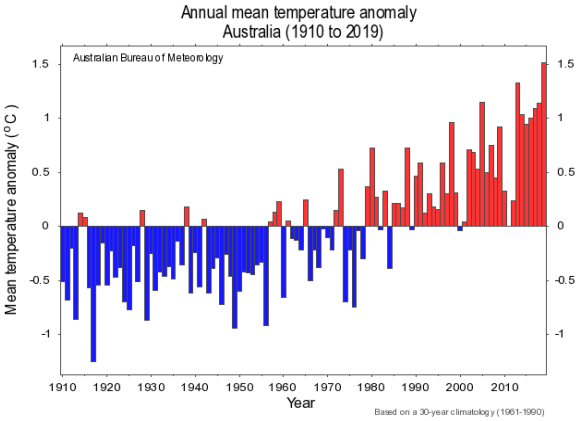


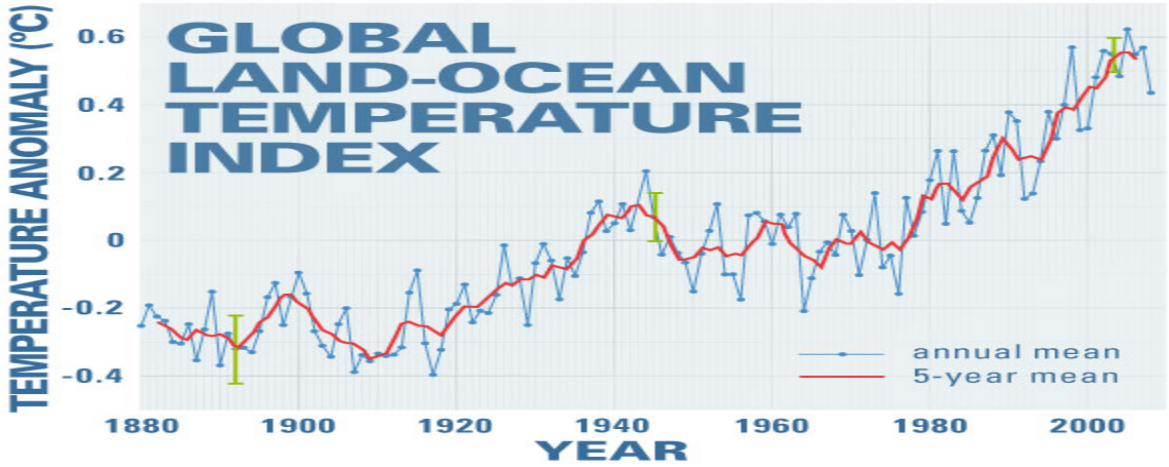
Above – CO2 measurements from Cape Grim, Australia – *'Mean carbon dioxide in ppm.'* The Annual Summer to winter fluctuations from 1976 can be clearly seen in the graph above and every summer was a little bit higher than the summer before. This was **76 ppm increase in just 44 years** (*or over **100 ppm rise in our atmospheric CO2 over the last 60 years***).

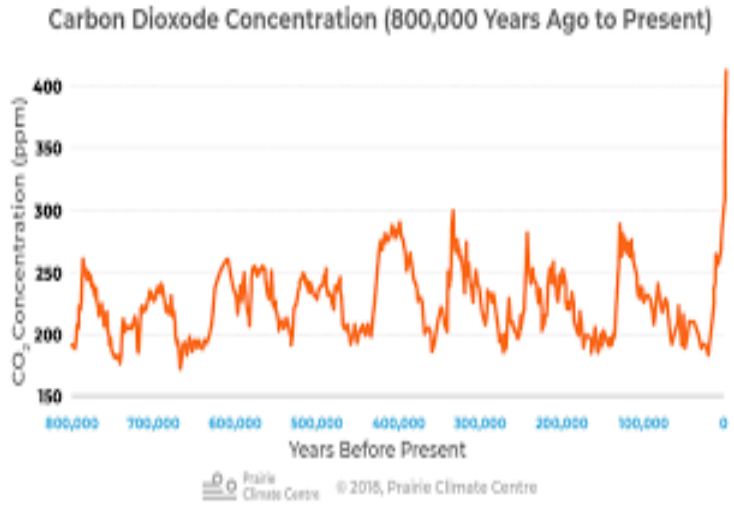


Right - Total U.S. Greenhouse Gas Emissions showing the five main sectors responsible for emissions.
1 Transport 29% 2 Electricity 28%
3 Industry 22% 4 Commercial and Residential 12% 5 Agriculture 9%









Note – In the last 800,000 years, the Concentration of CO2 in atmosphere was between 180 and 300 . In the last 150 years, not only did it rapidly shoot up past 300ppm, but it has also passed 412 ppm. The magnitude and rate of rise is much higher than at any time in the past 800,000 years and is clearly not normal.

The link below, lists 200 worldwide scientific organizations that hold the position that climate change has been caused by human action. These can provide ample detailed proof, if still needed. This Op-ed is not about proving climate change, but showing effective solutions to specific problems. http://www.opr.ca.gov/facts/list-of-scientific-organizations.html

Climate Change – 98% of Climate Scientists accept that human induced climate change is real, will be extremely damaging and is primarily the result of a rapid rise in greenhouse gases in the atmosphere. The biggest source of these (by far) is burning fossil fuels like coal, gas, and oil. The single biggest contributor is CO2 and the graphs above clearly show that atmospheric CO2 is way above any levels experienced in the last 800,000 years. We have seen an increase of 100ppm in our atmospheric CO2 over the last 60 years.

I am going to proceed on the assumption that the reader already understands and accepts that Climate Change is real, is speeding up, and will get worse as atmospheric CO2 rises, and will continue to get worse until the level of CO2 gets back to levels significantly lower than today's level of 412ppm. On a per Capita basis, Australia is among the worst in the world (with perhaps only Saudi Arabia a few percent worse). This does **not include fossil fuel exports** (where Australia's coal and gas exports are also extremely high).

I also have assumed that the reader already knows and accepts that Climate Change means that **extreme weather-related outcomes (droughts, fires, floods, cyclones and extreme heat days) will become more common as a result of the increased energy in the atmosphere from Global warming. Things like Coral Bleaching obviously are related to global warming as is the melting of an estimated 475,000,000 tons of ice <u>each year</u> in the Artic and Antarctic. Higher average temperatures will reduce farm and marine productivity. <u>These will cost Australia many trillions of dollars</u>. Climate Change will cause rises in sea levels, and flooding and inundation of cities and costal land. Climate change will cause massive species extinction.** The question is **- *What can we do about this?***

I make those assumptions because I want to mainly **discuss solutions, not symptoms**. How we can go about reducing CO2 is the topic for this essay. There are people who believe that there is no viable pathway to a low Carbon economy that will maintain a high quality of lifestyle. I show we still have a viable path, and it is a better pathway than our current one.

THE PROBLEM - In 2017, in the USA, 29% of Greenhouse Gas emissions were generated by transportation, 28% from Electricity Generation, 22% by Industry, 12% from Commercial and Residential sources and 9% from Agriculture. Every country (including Australia) will have these five areas as the major contributors to their Greenhouse Gas Emissions (although proportions will vary) and so any effective reduction strategy will look to massively reduce all five areas. Large reductions in every area are the only way to succeed.

Global warming is ***<u>likely</u>*** to reach 1.5°C between 2030 and 2045 if it continues to increase at the current rate. (*high confidence*)**.** The impacts of climate change will become more and more serious as temperatures rise, but there is no sudden universal change at 1.5 or 2 °C. However, in a 'business as usual' scenario, 4 °C of warming, is possible in less than 100 years. Even 3 °C of warming would devastate the economy of Australia and that of the world. CO2 emissions from anthropogenic (man-made), from pre-industrial periods to the present, **will persist for centuries** to millennia and will **continue** to cause further warming and long-term changes in the climate system, such as sea level rise, with associated impacts **(***high confidence***).**

High quality for human life requires energy, for transport, food production, lighting, heating and cooling, water and waste management, agriculture, and industrial processes. Without cheap reliable energy, humanity will not be able to sustain itself and disputes over resources will rapidly develop. Energy is not a concept that we tend to often use, but a few seconds of thought will show that it is energy rather that the current technology that matters.

Once we made fire by burning sticks, then we started using whale oil and fossil fuels such as coal, oil, and gas; then electricity became a dominant energy source. Once we walked everywhere, then we discovered horses and sailing ships, then we developed steam power and trains and paddle steamers were the technologies of choice, then (with oil) cars and trucks and propeller aeroplanes, then Jet airliners, semi-trailers, Super tankers and container ships. We went from open fires to oil lamps, to incandescent light bulbs, to LED's and from cave walls to clay tablets, to parchment, to paper, to computers. At every stage, the current technology would have seemed a massive step up from what went before. Any sensible discussion must **first look at <u>what options are available</u>** and how they could be applied.

<u>Very low CO2 emission technologies</u> - To bring Climate Change under control, we need to quickly reduce CO2 emissions from burning fossil fuels. There are a range of possible alternative '*Low Carbon'*, energy **sources**. The three **most promising are Solar, Wind and Nuclear.** Other low Carbon technologies such as hydro, geothermal, hydrogen, wave energy and Biofuels can also play some part. There will be a limited role for bridging technologies, like replacing dirty power generation by burning Coal with a slightly less dirty option of burning natural gas. Gas does not solve the basic problem (emissions), especially if we account for fugitive gas emissions. Gas is mostly composed of methane, the most significant climate-warming agent after carbon dioxide. An estimated 19 per cent of Australia's greenhouse gas emissions are caused by gas. Clearly gas is not the solution.

Non-renewables (fossil fuels) like coal, oil and gas were cheap and reliable but, from their very name (**<u>non</u>-renewables**), we know they cannot go on forever. They will eventually be used up and run out or are limited (much like whale oil). **The world emits about 43 billion tons of CO2 <u>every year</u> (2019) from fossil fuels**. This level of CO2 emissions has **<u>increased</u>** almost every year, over the year before, for the last 100 years. There is no reputable climate scientist anywhere in the world who still thinks this is sustainable without **costing Trillions of dollars <u>each year</u>** in Climate Change and Pollution effects. So, what are our best alternatives? '**<u>Renewables'</u>**. Low carbon options can now fill most situations and can operate alongside fossil fuels and must take more of the load each year. The aim is to reduce our CO2 emissions by 50% by 2030 and reduce the remainder by a further 50% by 2050.

Renewables and non-fossil fuels - Wind and solar are already cheaper, and cleaner, and a much less polluting way of producing electricity than burning coal, oil and gas. They have three major drawbacks that have held them back in the past. The first is they **<u>were</u> too expensive**. The cost of solar panels and storage, and the cost of wind turbines have all now dropped to make them, **now <u>the cheapest form of generation</u>** and supply in most situations.

The second issue is that they are **intermittent** and so need to be combined with storage to make them viable. The sun does not shine 24 hrs a day and the wind does not always blow. The hot new kid on the block for energy storage is Lithium based batteries. There are different chemistries that will suit different applications better, but in general, short term energy storage in batteries has become much cheaper, safer, and longer lasting. They are much cleaner and more flexible than Gas Peaker Plants and are much faster reacting so can track demand much more precisely. What batteries do best is to store short term oversupply (like mid-day solar) and release it for peak loads, like the evening peak. They help with oversupply, undersupply, and load fluctuations. They are like a rainwater tank in that they store oversupply and provide the resource whenever it is needed. They can be topped up and used many thousands of times, not just once (like bottled water). If we have good energy storage, we can get the maximum benefit from our low carbon options. These are cheaper, extremely reliable when combined with storage, and almost 100% free of CO2 emissions.

Pumped Hydro - The current leader (by a large margin), in energy storage, is pumped hydro although batteries are making rapid gains. In most cases, pumped hydro only recovers 70 to 80% of the energy used to fill the storage but this energy is from very low-cost renewables (no CO2 and no fuel costs), or cheap power that was surplus to requirements. 75% efficiency does not matter nearly as much as that it is CO2 free and can store large quantities of energy for long or short periods, as required. Fossil fuel efficiency is much worse than this and emits almost all the CO2 emissions affecting the climate. These two forms of storage (which are both proven, existing technologies) are somewhat complementary. Batteries are small, very efficient, quick to react and excellent at load following. Hydro has the potential to store vast quantities of energy. River hydro is pure, CO2 free generation but is limited in its ability to expand and has many environmental impacts. Pumped hydro has almost unlimited potential to expand. There are minimal environmental impacts because reservoirs are small and river flows are not disturbed. We should build at least 20 large pumped hydro storages all around the country. These will maximise the potential of low CO2 renewables and eliminate the need for any new non-renewable fossil fuel generation and the billions of tons of CO2 emissions it causes.

A study at the Australian National University (ANU) identified about 3,000 low-cost potential sites around Australia with head typically better than 300 metres and storage larger than one gigalitre. Roughly speaking, 1 GWh of energy storage requires 1 GL of stored water at 400 m head. The sites identified have a combined energy storage potential of around 163,000 GWh. **The potential pumped hydro energy storage resource is almost 300 times more than required.** Developers can afford to be very selective since only about 20 sites (the best 0.1% of sites) would be required to support 100% renewable electricity generation.

Other options such as Redox Flow Batteries, hydrogen, compressed air storage, molten salt heat storage, gravity batteries, geo-thermal options, capture and storage of bio-methane for generation to cover peak loads and a range of other potential technologies may

contribute to storage solutions. In the short term, batteries and pumped hydro are ready to go and proven economic and reliable. **Solar and wind, with storage**, could make massive gains over the **next ten years**. Often, wind and solar are somewhat complementary, particularly when distributed across the country and linked to an efficient grid. Often, when solar is poor, wind may be higher. They will produce better results together than either alone. When combined with batteries and pumped hydro, they can already go a long way to eliminating the need for any power generation by burning thermal coal or gas or from diesel generators and allow the use of more renewables for cheaper and extremely low CO2 emissions.

The third issue is that **solar and wind are not particularly dense**, so need large areas to be effective. In Australia, we have ample suitable land for grid scale solar generation and while more limited, we still have plenty of opportunity to increase wind generation. A further advantage for Solar is that a lot of roof-top solar for Photo Voltaic (PV) and solar heating can be placed on most roof areas with almost no impact on land use. These distributed generation options can take the load off the grid. Within the next ten years, rooftop solar and home battery storage like the Tesla Power wall, or perhaps 'vehicle to grid' electric cars could add many gigawatts of virtual power stations which will make the grid more stable and provide convenient and effective storage for excess power generation from solar and wind. With auto-bidder options, batteries will make fossil fuel generation even less essential. Even modest grid storage (like that installed in South Australia) can be a low-cost supporting technology that is far more effective (and far less problematic), than gas. Grid scale battery storage is already a very cost-effective, short-term storage, and is getting better and cheaper each year.

By just using these four technologies (Solar PV, Wind, Battery storage and Pumped hydro), we can already **totally remove the need for any new fossil fuel generation** and provide a cheaper cleaner alternative that is almost completely Carbon free. Electrical power generation from renewables reduces our dependence on big companies, foreign countries and vulnerable generation and massively reduces our CO2 emissions. It should be a very high priority, and it already exists. Opposition is from system inertia, old industries, and fossil fuel companies.

Just how could a renewable power system work in Australia?

This will take time and resources and we have wasted a lot of time, but we can still get so much done in the next ten years. We need to follow the science and take advantage of the new opportunities scientists and industry offer us. Of course, it will be expensive, but renewing, upgrading Australia's power generation and distribution grid was always going to cost a lot, for any technology. Compared to the cost of the military or the recent and proposed tax breaks for the wealthy, or Covid related expenditure, or the program to lock up boat refugees, this is cheap, and **the long-term payoffs are much better**. Renewable generation is cheaper than non-renewable electricity generation. We do not need to pay for coal and gas

each day, and sunshine and wind are free and inexhaustible, and we will not add megatons CO2-e per year to the atmosphere. Australia's health, and long-term viability are at stake.

The second thing is to say we can add more batteries and more pumped hydro and more (cheaper) solar and wind generation **every year**, and it will all work with existing non-renewables. As existing power stations become obsolete, become too expensive or we need to further reduce greenhouse gases; the non-renewable generation is phased out. Nuclear and grid improvements would also follow this patten with their contribution taking longer, but further contributing to decarbonising our economy. In 30 years, our CO2 emissions can easily be less than 25% of today's emissions. Indeed, even without nuclear, it could be carbon free.

We start with every year adding a couple of battery farms at least as large as the one built in Honesdale, South Australia. At 100MW/ 129MWh, the Hornsdale Power Reserve was the largest lithium-ion battery in the world and is providing essential grid-support services. A 50MW/ 64.5MWh expansion, currently under construction, will soon provide almost 200MWh of storage and showcase the benefits that grid-scale batteries can provide to the National Electricity Market (NEM) and Australian consumers. **In its first two years of operation, the project saved South Australian consumers over $150 million.** The battery cost about **$90.6 million** AUD, but saved 150 million in first 2 years. Where are the next 20?

The basic plan is to have some base load power. Initially this is from running the existing conventional power generation as efficiently as possible which is usually at a fairly steady state. Eventually almost all this baseload power generation could be provided by Carbon free nuclear generation. Hopefully, this will be with LFTR's (see discussion - page 12). If nuclear is not available, pumped hydro must provide much more of this base load.

We need to have far more generating capacity from solar and wind than is required during the middle of a typical day. This means that there will usually be excess power which is stored in the batteries and pumped hydro. More renewables equal less CO2 emissions.

- Each day there is a demand peak in the evening (just as solar is shutting down).
- The batteries will then switch from storage (of excess power) to providing power to the grid (over and above the baseload generation). This is totally carbon free once it has been constructed. It perfectly tracks demand and has minimal impacts on the environment.
- The evening peak lasts several hours during which time the batteries will continue to provide energy and will be partially discharged.
- As the evening peak settles, the steady state baseload is again sufficient, and the batteries will sit and wait to be recharged.
- During the early hours, the steady baseload is eventually higher than demand and excess electricity is used to begin to recharge the batteries.
- There will often be a smaller morning peak before Solar (and/or Wind) fully ramps up and again the batteries will cover this difference.
- During the day, renewables will carry the main load and produce excess power, which is stored in the batteries (or hydro) ready to repeat this cycle and meet the next evening peak

The Hornsdale Power Reserve provides almost 200MWh of storage. Compared to Australia's annual power needs, this seems tiny. The initial 129MWh, was installed in just 67 days from the signing of the contract. We should be building more than double this battery capacity every year, **for the next 10 years**. If we added 2 similar sized units each year, this would be 4,200 MWh of battery storage capacity, which gets used 365 days/ year. This equals 1,533,000 MWh (1,500 GWh) of available storage per year (to support peak loads). This amount of high-quality load following storage is combined with pumped hydro. Pumped hydro will take a little longer to build (lots of jobs) but is also essential for viable storage.

At least 20 new battery farms like the 200MWh of storage at Hornsdale would make our power grid so much more stable and would make renewables much more viable. In its first two years of operation, the 129MWh/ day project saved South Australian consumers over $150 million. How much could 4,200 MWh / day save Australia over 10 years? With supplying morning and evening peaks and oversupply regulation, batteries can have a significant impact on grid stabilisation and ensuring renewables work well. One of their main advantages is we can install batteries within months, not years, and they pay for themselves.

What happens if the batteries are nearly full while there is more renewable generation than demand? This is where pumped hydro comes in. Computers and weather predictions can forecast this many hours before it happens, and massive pumps are automatically switched on to use any excess power to lift water into an upper storage. This is done any time there may be excess power. These pumps lift huge volumes of water into upper storage reservoirs ready to generate power, quickly and **anytime** it is needed. When there is no excess power, they stop pumping. Pumped hydro is slower and not quite as flexible or efficient as battery storage but could provide far more storage than we will ever need (see page 7) and store cheap excess power from our renewables (or any other generation source).

Most of our daytime power will come from our newly installed solar and wind. We have pumped hydro as our failsafe to back up battery storage and nuclear, or modest non-renewable generation, (e.g., gas) to keep a reliable baseload generation capacity. In addition, we will have upgraded the grid to efficiently collect and supply renewable electricity, and we will be well into our 30-year plan. Batteries will be the primary place power is stored as they are efficient and very good at load matching. However, at some stage there will be several days where renewable generation is so low that the batteries would be depleted. This is where all that energy stored in the pumped hydro comes to the rescue. Water is released to the lower storage, back through a turbine and around 75% of the (excess) energy used to pump water up to the top reservoir is recovered to power the grid or recharge batteries. In this way, solar, wind, pumped hydro and batteries can easily combine with modest baseload generation (nuclear or fossil fuel), to reliably power the grid (and CO_2 emissions are massively reduced). Large inland solar arrays could also be dedicated to filling pumped hydro storage.

Initially, most solar electricity generation will be either rooftop or within several hundred kilometres of major cities. At some stage we may well choose to construct long distance transmission grids like China's 3293km, direct current Transmission line that can

carry 1,100 Kilovolts to take advantage of cheap land (sunny deserts), and different time zones (= full solar generation deeper into the evening demand peak). This line is expected to reduce China's coal consumption by around 30 million tons per year. We have a similar opportunity as we could cross our continent to get two hours extra solar every day and use more wind, 24 hrs a day. Going East/ West helps match solar generation with peak demands, and North/ South helps to reduce the impact of weather systems. Grid scale batteries allow renewable power to continue after solar drops out (night). Wind generation can make a greater contribution with long-distance transmission (Roaring forties Trade Winds). With Renewables + Grid + Storage, + Nuclear, there is zero need for any fossil fuel generation.

Could we do without any non-renewable or nuclear generation? In theory, there is no need for any baseload generation. In the next 10 to 20 years, this will not be an issue. There is no expectation that existing non-renewable generation will be closed. Clearly, the expectation is that as existing power stations become obsolete or unviable, they will be replaced by renewable generation. In the medium and long term, renewables will be much more reliable if there is a modest (say 25%) baseload generation capacity. The best option for low CO2 emission baseload generation is nuclear (See sections following). Let me make two points -

1 Nuclear generation worldwide is currently larger than either solar or wind generation.
2 Statistically (based on deaths caused), nuclear generation is the safest form of generation and is around 300 times safer than using coal to generate electricity. This is before we even consider the advantages of zero CO2 emissions and pollution.

Since these concepts are not familiar to many people, let me restate the solution.

- Most of our electricity generation in 20 years comes from Solar and Wind.
- Hopefully, we will get some of our baseload power from LFTR (Thorium). These are walk away safe, produce zero CO2 emissions, and have low radioactive waste issues.
- We should use funds saved by removing all fossil fuel subsidies to build large solar farms, wind farms and transcontinental transmission lines and more pumped hydro.
- A lot of large Pumped hydro plus grid scale battery storage is needed, for stability.

In ten years', on a typical day – **At mid-day**, solar + wind + modest baseload means our entire electricity needs are easily being met and exceeded. The excess power is being used to recharge the batteries in over 20 battery farms, at least as large as the one built in Hornsdale, South Australia (each over 200 MWh). If the computers projection and weather map say we may have more power than we need to fully charge the batteries, the pumped hydro should be automatically switched on to lift water up into upper reservoirs, using free power from sun and wind (no fuel required or only cheap surplus power). No extra CO2 being produced. If the transcontinental transmission lines are operational, they will be used to send power from the sunny inland (or windy west coast) to the population centres of the east coast. Around 4PM, solar is starting to fall away significantly (in the east) but the transcontinental inter-connector (similar to that built by China), will continue to deliver renewable solar power for another 2 hours. With batteries and wind generation, this line will transfer power, 24 hr/ day.

- As the east coast solar and wind + the transcontinental inter-connector reaches the point where they are not sufficient (even with the small baseload contribution), the batteries begin doing their magic of perfectly matching the loads. If needed, the pumped hydro can also be used to cover peak loads, but highly efficient batteries do the initial balancing.
- During the night, the grid can balance battery storage to ensure that all projected demands can be met. Wind power plus base load power, (hopefully from at least some CO2 free, LFTR generation) continues to supply grid needs through the night and charge batteries (or pump hydro). Wind turbines can work 24 hrs/ day (365 days/ year) with zero CO2.
- Excess power during night, (from wind or baseload), goes to batteries or pumped hydro.
- Early morning, batteries again may be needed to meet a morning peak (before solar reaches a high level). Solar power could be sent from the east to South Australia and/ or West Australia to help cover their morning peak via the transcontinental inter-connector.
- Solar or wind farms in the centre of Australia can benefit from cheap land and less cloud.
- Solar or wind farms (north and south) may benefit from different weather systems.
- Often when it is too rainy (or stormy or dark) for good solar, wind can be producing well.
- Anytime both wind and solar and the interconnector cannot find sufficient renewable power, the batteries fill the gap. Pumped hydro takes over supplying power when needed.
- Baseload power from gas or pumped hydro will quickly begin replacing coal and oil generation (gas is last to go). Baseload power from existing non-renewable (fossil fuels) generation should eventually be replaced with CO2 free, Nuclear, or upgraded renewables and pumped hydro to become 100% CO2 free. All of these are able to load match to cover peaks if needed, but batteries and pumped hydro are best. Batteries are like cars (smaller, quick, convenient, and efficient). Pumped hydro is like trucks, less efficient but just a few can carry big loads. Wind is less predictable but (with storage) is like baseload.
- It you don't have sustainable energy, then, by definition, you have unsustainable energy. Why not get serious about making our energy sustainable and reduce our CO2, right now.

Nuclear - The third of the low carbon options is nuclear generation. It clearly does not suffer from low energy density issues. It is ideal for providing baseload power that can be combined with batteries (and pumped hydro) to provide continuous electrical power, in all conditions. It helps overcome intermittency from solar and wind and can provide electricity in any quantity, and in all weather conditions. In many cases, nuclear power may be more expensive than renewables but is excellent at providing stable, safe, reliable power that generates zero CO2 during operation. In many people's mind, there is a higher risk from nuclear than is really the case and a lower risk from coal than is the case. In some countries, nuclear generation contributes over 50% of all power generation and because it is 100% free of CO2 emissions, it should be considered to support renewables and reduce CO2 emissions.

Nuclear energy has several major problems that have made it a **non-preferred option.** However, there is real potential that almost all these issues can be addressed (and almost eliminated) by Generation IV, **Small Modular Reactors (SMR)** that are being developed by many countries around the world. In particular, SMR's based on molten Salt and Thorium (**liquid fluoride thorium reactor - LFTR**; often pronounced *lifter*)) offer huge potential and

have run as demonstration research reactors. Replacing coal fired Power Stations with several molten salt reactors (LFTR) should be lower cost, very reliable and is statistically much safer than the coal fired generation they replace. They can make needed medical isotopes, will be more reliable (because they are modular) and produce zero Greenhouse gases or pollution.

The main issues with current Nuclear - *and how SMR's (particularly Molten Salt Thorium Reactors) address these issues*. Currently almost all nuclear reactors use some form of the uranium/ plutonium cycle with high pressure, light water cooling, **P**ressure **W**ater **R**eactors - PWR). These reactors are essentially carbon free during operation and statistically 300 times safer than conventional coal fired generation, but they do have some serious drawbacks.

1. They produce significant amounts of very long-lived **radioactive waste**. Coal fired generation produces much larger quantities of waste and climate changing air pollution. Radioactive waste is a very serious issue that can be managed but not eliminated. On the other hand, LFTR reactors produce several orders of magnitude less radioactive waste and the waste they do produce remains radioactive for around 300 years, not over 10,000 years.

2. Weapons grade fissile material. There is already a massive quantity of bomb grade material in the world. No nuclear power reactor is particularly good at producing weapons grade nuclear material, but this is a bigger issue for Uranium/ plutonium cycle reactors and their plutonium and much larger waste stream than for a molten salt cooled Thorium reactor. LFTR's allow continuous reprocessing to remove gasses and other products so can use a much higher percentage of their fuel. Indeed, over time, Molten Salt reactors offer the safest option for disposing of stored radioactive material (nuclear waste and also fissile material) as they can incorporate it into their fuel cycle and so turn high risk, 10,000-year waste into much lower volumes of shorter life radioactive waste (300 years for LFTR). Because of this, LFTR's will be inherently safer, while generating vast quantities of clean, low carbon, energy

3. Light water reactors (PWR) must keep water at **extremely high pressure** to generate electricity. If they were to lose pressure (leak or are damaged), the water will flash to steam and perhaps even break down to produce hydrogen (H). This is what happened in Fukushima after the Tsunami knocked out cooling. This (H) explosion risk requires massive containment buildings which are not required for LFTR reactors. As there is no water required for cooling there can be no pressure or hydrogen explosion risk. Without water, there is no need for high pressures and so no massive containment structure is needed. There is no risk of a melt-down with salt, so no dangerous material state change is possible (like, water to steam).

4. Uranium fuelled, light-water reactors **typically use solid fuel** and control rods. They are monitored to ensure they can never go critical (run away heating and perhaps even meltdown) as they use fissile material. Statistically, nuclear power is currently the safest form of power generation (see table below). Uranium reactors are safe because of procedures and engineering. LFTR reactors are inherently safe because of physics. They contain very little fissile material (they contain fertile material which will be slowly made fissile, which is then 'burned' to produce heat). They need to be monitored to keep the reaction going. If they get too hot, natural expansion means the reaction slows down which means there is no way for them to melt-down. Further, they all incorporate a plug of cooled salt that melts if the temperature gets too high which allows the reactor contents to automatically drain away into safe storage vessels designed to totally shut down all reaction. These features result in what is

often called ‘Walk away Safety’ which means that whatever happens, the natural state of LFTR reactors is to shut down and cool. They cannot melt down. They are extremely poor at producing bomb material. They have no risk of pressure explosions, or gas explosion and can’t release radioactive gases. They use much more of their fuel. They produce much less radioactive waste. If based on Thorium, their fuel is more plentiful. They can remove waste.

5. Because a LFTR has its fuel as a liquid, it is can continuously reprocess the fuel to safely remove unreacted gases and waste as well as valuable materials (including medical isotopes and materials needed for space flight) that are difficult to source in any other way.

6. Uranium fuelled, **P**ressure **W**ater **R**eactors (PWR) are complex structures that are large and **very expensive**. They need to have large areas around them (for safety and containment) and to be sited near large bodies of water. Because of these needs, they are all built as one-off constructions, and each is slightly different to all the others. Imagine if every jet airliner had to be built, on-site, at airports, using unique designs. LFTR reactors are **smaller**, and **built in a factory** (cheaper), with greater quality controls and uniformity. They can be delivered to the site on the back of a truck and so are much quicker to commission. They require no large containment buildings as they operate at low pressure and do not need to be near water as they can be air cooled (almost zero risk from earthquake, flooding, or Tsunami). Because of this and their inherent design features, they have built-in ‘*walk-away’* safety. Many designs choose to build SMR’s into the ground to add further levels of security and safety and remove them from sight. Molten salt reactors can eliminate (safely burn) some forms of nuclear waste and can produce safe valuable by-products, which conventional nuclear reactors cannot do.

7. Uranium fuelled light-water reactors typically are only used to produce large scale **electrical power**. They are not well suited to smaller or remote sites or non-grid applications (e.g., mining), or to produce **industrial heat and medical isotopes**. LFTR reactors will be small, require far less monitoring, are well suited to smaller scale or remote applications and can also be used to produce heat for industrial processes and residential or commercial applications. Safe heat production for industry is important for reducing our CO2 emissions.

8. Redundancy and back-up. By using **multiple SMR** units, you achieve high outputs and **a high degree of redundancy**. This allows uninterrupted power during any maintenance. Conventional reactors need to be fully shut down regularly for refuelling and maintenance.

9. Uranium fuel is less common than Thorium although there is plenty of both fuels. Thorium is easily extracted and is often a wase product of Rare Earth mining. In addition, Thorium reactors ‘burn’ a much higher percentage of their fuel (so are much **more efficient).** Molten Salt reactors can be used to extract huge quantities of energy while decontaminating uranium reactor waste. This seems a better, and more permanent use than burying it.

10. Nuclear generation has had three high profile incidents that were all related to cooling failures. These were Three-mile Island, Chernobyl, and Fukushima. LFTR generation does not use any high-pressure water, for cooling. At any time, you can dump the reactor contents into totally safe storage. A freeze plug to makes this process completely automatic if excess heat somehow built up. This is walk-away safety as it relies on physics, not people.

Historically, nuclear power has been a very significant source of carbon free energy. In 2015, Nuclear generated 11% of all the world's electricity, Coal was 39%, Gas 23%, Oil 4%, Hydro was 16%, Solar and wind 5% and all other options produced 2%. About one third of all generation already comes from CO2 free sources and renewables. Clearly the best way to cut CO2 would be to greatly increase the percentage of renewables and nuclear. We need to decide if avoiding the extremely low risks of nuclear generation, is worth accepting much higher risks from non-sustainable fossil fuels and the **certainty of brutal Climate Change**.

The fossil fuel industries have done a great job of making people uneasy about nuclear (**their greatest competitor**). Generation IV plants are much safer than old nuclear generation and LFTR have the potential to be much safer, again. Nuclear generation is statistically already the **safest** form of generation (as well as much cleaner in terms of CO2 or smog). If we look at the deaths per TWh that can be attributed to the major sources, we see -

Black Coal = 24.62 deaths per terawatt hour of electricity generated (brown coal worse)

Oil = 8.43 deaths

Gas = 2.82 deaths

Nuclear = 0.07 deaths per terawatt hour of electricity generated.

Clearly even with old nuclear technology, fossil fuel generation causes far more deaths than nuclear generation. It also causes more air pollution, more waste and dumps billions of tons of CO2 into the atmosphere. Nuclear does none of these things. It was political decisions that shut down Thorium research and Molten salt (**no use for making bombs**). We now need to decide if our top priority should be CO2 emission reduction and making renewables ultra-reliable with some nuclear (LFTR best), or are we going to stick with another thirty years of burning coal and gas and just accept the Climate disaster as too hard and nuclear as too scary? Nuclear, is not required in the first 20 years as existing Coal and Gas plants slowly become obsolete. Massive increase of wind and Solar can easily carry the load if supported by enough batteries and pumped hydro. However, in the long term, some baseload generation from nuclear will make the entire system more stable and reliable.

Large quantities of safer, low CO2 energy combined with renewables and storage and removes the need for non-renewable generation. LFTR's and SMR (Small Modular Reactors) are excellent complementary technology to support renewables. They are likely to be available in less than a decade (about the time renewables plus storage could start to need baseload support). LFTR power generation is safer, and cleaner with much less waste. Molten Salt reactors can turn conventional nuclear waste and fissile material, into large quantities of zero CO2, electric energy. LFTR can also produce much needed medical isotopes and would an excellent source of zero carbon, industrial heat. Currently, outdated nuclear regulation is a major limitation on introducing nuclear. This is due to poor information, fear of the unknown (for public, not generators), old ideas, and the lobbying from competing fossil fuel industries.

Some base load power will let these changes occur quickly. It would be far better if this was CO2 free nuclear. This is safer, cleaner, and better. However, if we need to wait a few more years to get LFTR 's instead of conventional, large scale Pressure Water Reactors

and only get rid of dirty polluting coal and oil generation and need to retain some gas generation and a lot of renewables with storage, that may be an acceptable second choice.

Very large pumped hydro capacity plus support from batteries can meet any baseload generation needs with zero fossil fuel inputs if linked to sufficient renewable generation, without any input from nuclear. However, a more diverse and distributed grid should be even more reliable if it has some baseload generation from small modular reactors or LFTR's. These are CO2 free and make 'storage supported renewables' extremely reliable.

The case for some Baseload generation in Australia

Hopefully, the study by the Australian National University (ANU) which identified about 3,000 low-cost potential sites around Australia with head typically better than 300 metres and storage larger than one gigalitre, has helped show that batteries plus a lot of pumped hydro can make near 100% renewable generation possible. However, despite the incredible urgency to reduce global atmospheric CO2 emissions with renewables, I do not yet see much evidence of understanding and willingness to do enough. This would require many pumped hydro storages that are mostly held in reserve. What will probably happen is that some version of non-renewables (including Gas Peaker Plants) will be kept for supplying baseload power so that only half the storage needed for 100% renewables will be built. The fossil fuel lobby and the government will claim they have cut emissions by over 50% which will be good, but it is not enough. We need to cut emissions by 90% not 50% to be effective. We will have failed our children, our duty, and the planet and Climate Change will get worse.

Imagine the situation where we have high demand (winter), when we have had a prolonged and widespread period of cloudy skies and low wind. Our electricity needs are high, and our generation capacity will be lower than normal. For a few days (or weeks) the batteries and available pumped hydro have no problems. At some stage it will become harder to keep the lights on. How much easier to trust renewables if we had another totally reliable generation source that was 100% CO2 free (and free of all aerosol pollutants) and could generate at least 20% of our needs, no matter what the weather was. If this is gas, there will be a lot of pressure to use it and so we may never reach required levels. If it is nuclear, we will join over 30 other countries that have safely used CO2 free nuclear generation for years.

Australia prohibits the use of nuclear energy generation. The legislation is '140A Commonwealth Environment Protection Biodiversity Conservation Act, 1999'. What a gross misnomer. Nuclear energy is one of the safest forms of generation, around 300 times safer than Coal generation (see previous section) and is completely free of emissions of CO2, soot, Sulphur, mercury, Nitric Oxides, and other combustion products. We have seen an increase of 100ppm in our atmospheric CO2 over the last 60 years and unchecked Climate Change will do massive environmental damage including destroying the 'Great Barrier Reef' and send hundreds of our unique species extinct. When this '*Environment Protection Biodiversity Conservation Act, 1999*' was written, scientists knew about climate change, but it was not the critical issue it is today. When cars were first introduced, a man with a flag and bell had to walk in front of the car. We need to get rid of stupid laws. Times and technologies change.

Molten Salt Thorium Reactors almost eliminate all nuclear issues that should concern people. PWR nuclear generation is still much better than coal if we want to reduce Climate Change.

19 of the 20 nations we compare ourselves with (the so called G20 nations) have nuclear generation capacity. We do not. We mine, and sell, 12% of the worlds Uranium (including to China) and have 31% of the world's known uranium reserves. We operate a nuclear reactor at Lucas Heights in Sydney, to make medical isotopes. Uranium has about one million times the energy density of coal and emits no greenhouse gases. Ontario in Canada has two nuclear plants (Pickering and Darlington) which together produce 45,000MWh of electricity. This is just over 55% of Ontario's needs. The balance comes from Hydro (24%), Wind (10.6%), Gas (9.5%), Other (0.3%), Coal (0%). Their CO2e intensity is 55 grams/ kWh. Australia's CO2e intensity is around 1000 grams/ kWh. Our worst coal generation power station is Loy Yang in Victoria. It emits **19 million tons of CO2 every year** and over 1180 grams of CO2 per kWh. Clearly, we and the world, would be much better off if this power station was replaced with a CO2 free nuclear power station or renewables.

But what about the radioactive waste? Thorium generation has a tiny fraction of the waste of conventional nuclear generation. Even PWR produce only a tiny volume of waste which can be safely buried. However, a process to recycle and reuse this 'so called' waste has been developed. Only about 1% of the original mass of the uranium fuel was consumed. With reprocessing, most of this material can be reused as fuel. It does not require any mining, and it does not produce any CO2. It produces vast quantities of energy which is safer than Coal.

While I believe most of the Anti-nuclear Activists had good intentions, some are clearly acting on behalf of the fossil fuel industry. Further, there has been a lot of work done to ensure that cooling accidents are not possible, in the ways early reactors experienced, (as a result of cooling loss), so the risk is now even lower for PWR and much lower for LFTR. Nothing in the world is 100% safe but compared to Climate Change or non-renewable generation, nuclear comes very close, with LFTR's even better. For Australia to not consider nuclear is to almost guarantee we will keep some non-renewable generation. This will slow down and reduce our switch to zero carbon dioxide emissions. I do not think we should bet the world's climate on a few people's preference that is not supported by evidence. Currently, the world produces over 11% of all electricity from nuclear reactors. Renewables + storage + some nuclear = Rock Solid, inexhaustible, lower cost, 100% reliable power with zero CO2.

Will we need to shut down existing fossil fuel Industries?

No, they will mostly be replaced naturally. Removing the subsidies that go to fossil fuels (which promotes CO2 emissions) and putting these funds into building renewables, is a great first step to upgrading our electricity supply. A relatively small pollution tax on fossil fuel emissions (particularly CO2) and building essential infrastructure (grid improvements,

battery farms and pumped hydro plus very large solar and wind generation), will help ensure that these changes are automatic. Non-renewables like coal and gas (the things that are causing the problems), currently receive massive support from government welfare (e.g., subsidies). We built the old infrastructure to support the fossil fuel industries a long time ago and rather than trying to repair the old stuff that is causing us so much damage, why not just go straight to the things that will be our future (and save billions of tons of CO2 being added to the atmosphere). Our emissions are damaging our reputation. I am confident that the fossil fuel industries have had their time in the sun and do not need (or should get) welfare. Our increasing need for electricity will allow them to operate alongside renewable generation, which will slowly take over as non-renewables become obsolete or need replacement.

What are the next steps?

The four technologies above (Solar, Wind generation, Batteries, and Pumped Hydro), are all available right now, as is conventional Nuclear. SMR's are likely to be available soon (and probably LFTR's also). They can all impact Transport, Electricity, Industry, residential and Commercial emissions, and Agricultural emissions (main sources of Greenhouse gases).

What are the essential steps to get us past 50% CO2 reduction, ASAP?

Energy conservation – Insulation, use of heat pumps, LED lights, efficient appliances, more efficient processes and machines and practices (like teleconferencing) can be introduced with today's technology and at little cost, if savings are included in the calculations.

Install renewable generation and storage and increase this capacity every year. Large storage capacity is the first step alongside increased solar capacity (at grid scale as well as domestic), and wind farms where appropriate. These all need to be added to our Electrical system, ASAP. The aim is to halve our CO2 emissions within the next ten years. This is not about supplementing dirty coal but rather putting enough capacity into the grid that coal generators will shut down as soon as they get near the end of their economic life, as they are no longer required or wanted or able to compete with cheap renewables. Building pumped hydro and renewable generation capacity is like building roads in a new housing estate. They may not be 100% utilised for a couple of years but without this infrastructure, the primary aim cannot happen. If renewable capacity is higher, low CO2 options (like green hydrogen or electrification of our vehicle fleet or production of low emission steel) can emerge. If we protect our tourism, farming and marine production and begin a rapid transition to a low Carbon economy, we can maintain our standard of living. Failing that, we must rely on the rest of the world to save us from runaway Climate Change within the next 60 years.

Price signals – Fossil fuel subsidies should be rapidly reduced to zero. These funds will build the solar farms and wind turbines and storage. An effective price signal could be established by applying a **pollution tax** (universal carbon price) **on fossil fuels** at the mine and import level. This would be both cheap and efficient. If set at a reasonable low level (say, at least two billion dollars), this will effectively provide a genuine cost on those dumping millions of tonnes of CO2 into the atmosphere. It also provides a significant pot of funds to facilitate projects that speeds up our reduction of Greenhouse gas emissions (*stick and carrot*). In

2016, our (Australia's) total carbon emission from fossil fuel consumption was 392,400,000 tons (about 500 megatons of CO2-e per year). This Fossil fuel **pollution tax** need only be small on a per ton basis (about $4/ ton of CO2-e). These funds are used to support positive behaviour like solar PV or hot water on rooftops, domestic storage solutions, insulation, improved public transport, and electric charging stations. These should all be supported in any way possible (including research, education, subsidies, tax, and regulations). With a small price signal, many desirable changes will flow with almost no additional cost or compulsion. Putting a price on dumping CO2 into the air would change the balance in favour of renewables. Two billion dollars/ year is less than $100 for each Australian. That does not seem much to secure our future, particularly if 100% of these funds are used to provide real benefits like improved public transport, subsidies and systems upgrades or education, and re-training. It should be supported by public funding by Government (as are all upgrades), future needs and meeting our international commitments, and by private/ public partnerships.

A pollution Tax on any fossil fuel (for any purpose), is clearly the best mechanism but if it is judged to be too politically difficult, then just replacing the massive subsidies on all fossil fuels would provide over 10 billion dollars per year for major projects. This alone pays for a lot of the needed upgrades. Taking a further 2 billion from general revenue for CO2 reduction programs and subsidies for individuals (not business) would be a huge step in the right direction. The extra two billion dollars/ year could enhance CO2 free heating and rooftop solar, better public transport, insulation, home storage, the switch to Electric Vehicles, improved air quality from less burning fossil fuels, plus some community support.

A modest Pollution Tax could ensure that other Government expenditure will not need to be so strongly impacted while providing a clear price signal to reduce CO2. Most of the funds to do the necessary upgrades will come from the reduction of counter-productive fossil fuel subsidies or from industry upgrades. Almost everyone will see some real benefits and polluting industries will have real incentive to make changes, but not be crushed out of existence. This should be almost exclusively about reducing emissions and not offsets.

Of course, there will be some loud protest from large polluters who have been taking a free ride by contributing nothing toward the damage they are causing. However, if 100% of these funds are returned to the community to help in achieving carbon reduction goals, there would be little protest from the general population. It might be too much to ask, but it would be best if politicians only had an annual oversight role rather than any direct control of these funds. If these funds were to be distributed by an independent, science driven body tasked to get the best and most integrated results, even this small but significant pot of funds would be transformational over the next 10 years. It would work even better if it were divided into several separate pots such as - A. Infrastructure B. Science and Education C. Transport D. Adaption E. Environment. These would only require small and cheap administration. These costs should be paid by the Government so that 100% of available funds can be dispersed. 400 million dollars of targeted strategic spending in each of these five areas, every year, for ten years would be transformational. Offsets can compete for these funds against all other options but mainly offsets are counterproductive and not needed.

Most people have some understanding of this problem so they will be willing to see serious funds used to address the risks from Climate Change (particularly if they can see direct benefits to them, plus long-term sustainability). Already, surveys show that a large majority of Australians favour rapidly increasing our use of renewables and it is the government and vested interests resisting this change. An education campaign would further support this move and is likely to provide much more positive support than negative reaction.

Two billion dollars per year + lots of renewable generation and storage will quickly set us on a path as a low Carbon economy. Almost everyone would pay less than $100/ year extra and this is part of their fuel and electricity bill or be just part of the price of products. They would get back far more than $100 of extra value. This value could be as better health, or better air and water quality (from reduced pollution), or subsidies for roof-top power or improved public transport. It may be the support for switching to a largely electrically powered vehicle fleet. It may be our clean sustainable future, or less extreme weather events. Low CO2 supports a fairer world with less military threat from resource competition and billions saved because the sea level rise and climate change is less than if we had not done these things. Australian could show leadership rather than being international deadbeats.

Supporting those miners, farmers or others who are directly impacted may seem unnecessary as people lose their jobs all the time but if these changes can be done while not causing unnecessary hardship, this also helps the changes, retains a greater element of fairness, and will reduce resistance to much needed change. It may be that these changes help Australia to continue to be seen as a clean, green, lucky country, that is fair and trying to do its part, instead of just as a major polluter. It may be that we can continue to enjoy huge benefits from tourism and protect and retain our unique wildlife. Perhaps it could help large scale water desalination helping green parts of Australia's vast, dry inland. Cheap, clean energy makes everyone's life better while Climate Change, pollution and competition for resources will make most Australian's life worse. Installing charging stations and grid scale battery storage or pumped hydro will move us toward a sustainable future. So would support and assistance for scientists, universities, industries and early adopters to help with changes.

Both domestic and Grid scale storage options need to be supported. Storage makes the grid more reliable, and less prone to blackouts. It provides a valuable use for excess electricity generation (from any source). This is particularly important for renewables. It takes away the fear of power outages if large generators drop out for maintenance or obsolescence or breakdown or the grid suffers damage. By supporting early adopters, these vital technologies will become mainstream much quicker and so will the benefits. Vehicle to grid options need to be supported by auto bidder, plus ensuring plug and system compatibility standards.

Electrically Powered transport – Electric vehicles (EV) are cheaper to fuel (you go much further on a dollars' worth of electricity than a dollars' worth of petrol), quieter, more reliable, need less service, have better performance (power and torque), and are safer than any internal combustion engine powered vehicle. They result in much lower CO2 emissions per km (even with electricity generation from fossil fuel) and almost zero from renewables.

In a few years, heavy electric powered transport options (like Tesla Cyber truck, Tesla semi and electric vans and buses) will be widely available and will reduce per kilometre costs and freight costs per ton. Planning and provision of infrastructure will allow huge inroads into reducing CO2 from transport. Lithium batteries will soon pass price parity with ICE (Internal Combustion Engines) cars. EV's already offer cheaper fuel (and the convenience of overnight home charging), and offer safer, and less polluting transport. Battery production is their main constraint. Every major vehicle manufacturer is adding electric models to their line-up.

Electric powered trains can be improved to make long distance haulage more efficient and reliable. Improved containerisation will allow better integration of road and rail and sea. High-speed electric trains can become more competitive with other transport including aircraft. Enhanced autopilot will be likely to impact both short road trips (Taxi and ride share) and heavy commercial transport. These changes will happen because they are better, safer and save costs, but reduced CO2 emissions are a vital bonus. If we plan for the changes, we can get more benefit with less disruption. EV's are potentially much better (even without less CO2). Planning and providing high-speed charging points in cities, towns and along roads or highways, helps reduce one of EV's major limitations, charging while away from base.

Electrically powered trains, electric short-flight planes (like trainers and light aircraft) and some ferry operations are considering electric (battery) powered options because they are now more economical, reliable and require much less servicing. These changes could grow faster with support. Less pollution is a bonus for their operators, but it is a significant advantage to Australia (CO2 reduction) and so early adopters should be supported.

SMR's - Clearly, the element that is likely to be the most difficult to incorporate quickly is the provision of Small Modular Reactors, like LFTR's. We need to start now with training engineers, bringing universities up to speed with SMR and molten salt nuclear generation and waste destruction. We need to remove Australia's legal impediments on nuclear generation if we are serious about reducing Climate Change and the huge environmental and economic costs it will cause. We need to begin to partner with overseas companies or universities who are further along this path. LFTR technologies should be made a priority. We will be in a better position to achieve a genuine low carbon future in 10 to 20 years' time if we begin the transition of replacing dirty, CO2 generating coal and gas generation with safe, reliable nuclear baseload generation, while we still have time. We have more than 10 years before existing fossil fuel generation will need replacement. Even then, renewables plus storage can meet our needs. At the least we can get rid of coal generation for gas only. If it is good enough to sell our uranium to the world, it is good enough for us to use it to reduce our CO2.

It will also take time for the public to understand the advantages and differences between different options for nuclear generation. Nuclear is already much safer, with lower emissions than coal. Many existing power stations still have a planned life of at least 20 more years, so the lack of a nuclear generation capacity for at least 10 years should not be an issue **if we start now**. Renewables, batteries, grid upgrades, and pumped hydro will all play a role in plugging any short-term gap. Batteries have a very rapid response (no delay) and they can

be ordered, 'off the shelf.' Electrical generation is one of the largest CO2 emitting sectors (along with transport - which also needs electrification to reduce CO2), so it will be important that we look at all opportunities for zero or very low CO2 generation, including nuclear.

Burning fossil fuels like coal, petroleum, and natural gas is the main cause of anthropogenic (caused by humans) CO2 increase in Australia; and deforestation is our second major cause. This is also caused by humans. Land management is clearly an area where a combination of laws, education, research, and financial support can put Australia, and its farmers in a much better position. Renewables plus nuclear may also be able to provide desalination and water management that may help to transform parts of inland Australia. Many of the solutions proposed to reduce fossil fuel use (the focus of this essay) will apply to agriculture and land clearing but of course, there are many other opportunities for Australian agriculture to reduce CO2 emissions as well as the use of renewable power.

Industrial processes like steel, cement, glass, aluminium, ammonia, and hydrogen production are all very energy intensive. The current processes are all major emitters of CO2. In almost every case, we use fossil fuels because they have to pay nothing for the pollution and CO2 they emit. With cheaper, renewables (or industrial heat from LFTR), and a small Pollution (carbon) tax on non-renewables, cleaner, more efficient processes become viable.

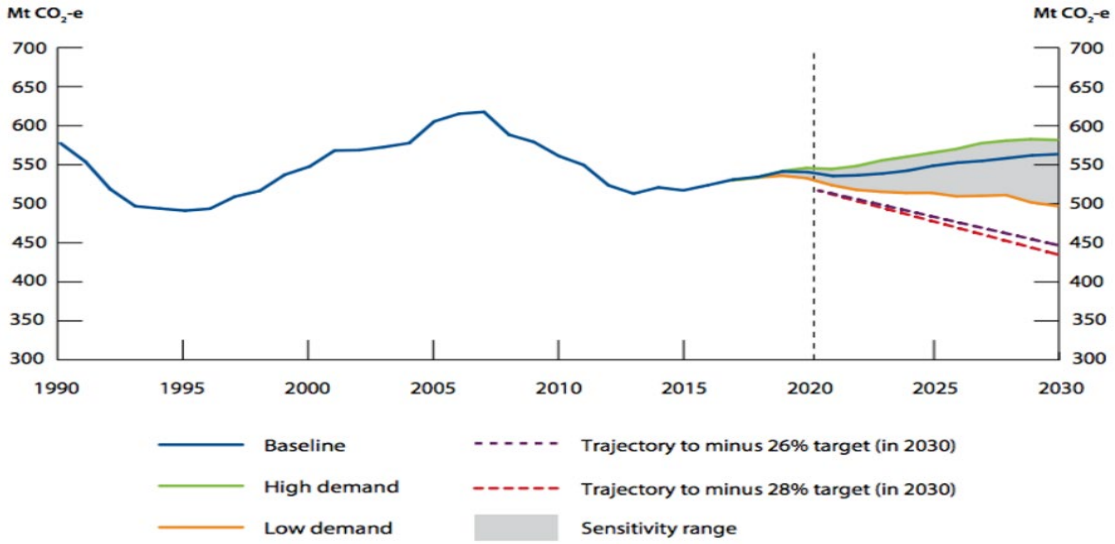
The Government says – We should promote low emissions steel production under $900 per tonne and low emissions aluminium under $2,700 per tonne. Steel and aluminium are important global commodities and thousands of people are employed in these industries in Australia, many in regional areas. Low emissions steel and aluminium could reduce Australia's cumulative emissions, while increasing economic activity and generating many thousands of new jobs in the long-term. They could also reduce global CO2 emissions.

Reality – Only a crazy person would not support the above statements. **Except we have done nothing to boost renewables** to allow this to happen (which it clearly could as we have all the resources needed). Without renewables or nuclear (the best low carbon options), this is a smoke screen for using more of our coal and gas and promoting '**business as usual'**. Hydrogen based direct reduction using green hydrogen from renewables is slightly more expensive than using a blast furnace, but it emits only 3% of the CO2 that we currently release (but we do not have the renewables to do this). The technology already exists, and it is a lack of renewables that stops us doing this now. Aluminium production is very energy intensive so if you want to produce aluminium but have no plan to switch most of the Australia's energy to renewables, you are essentially lying to the Australian public and simply doing more non-renewables (coal and gas) or wasting our hydro. Worldwide, about a third of all steel made now comes from electric arc furnaces. If we had low CO2 power, we could stop sending our raw materials to China and Australia could start producing low emission steel and aluminium for the world.

Australia is counting on cooking the books (carry-over credits, unfair starting point and weak commitments) to meet its inadequate climate targets. The government chose 2007 (our worst year ever) instead of 1995, so that it appears we have made at least a little progress. Near **zero net emissions** by **2050** should be our aim and halving our current CO2 emissions, within the next ten years, should be a minimum, not zero to 15% reduction at best.

From 1995 to our projected position in 2030, Australia will have not reduced its total CO2 emissions (per year). For this entire time, we have known what was driving man-made climate change. We have had plenty of examples of more extreme fires and droughts. We have watched the Great Barrier Reef go from almost no 'Bleaching' to regular massive bleaching almost every year. **In 2030, we expect to still emit 500 megatons of CO2-e per year (the same as 1995).** Our emissions have been over 500Mt every year since 1995.

In 35 years (1995 to 2030), Australia will have not lowered its annual emissions **= Failure**



We can see data showing the atmospheric CO2 levels go up every year. We can see that **15 of the 16 hottest years ever recorded have been in the last 21 years.** We have had to watch a 'Climate Denying' Prime Minster wave a lump of coal in Parliament and the leader of a party who claims to support rural Australia, claim no connection between Fossil Fuels, Climate Change and the droughts, fires, and floods we have recently endured. We have now had **432 consecutive months** that each have been higher than the 20th century average for each of those months (yet we still have people who claim to be Climate Change Sceptics, including the Government (**or is this just fossil fuel money that is doing the talking**).

Using accounting tricks to claim we are exceeding some arbitrary, outdated, and completely inadequate target should be an embarrassment to every Australian. Clearly, the world has made significant progress in developing technologies that can help, but we are not using them. If we had been aggressively trying to drive down our CO2 emissions for the last 20 years, our starting point would already be much lower and the technologies discussed would be so much more effective right now, with the costs lower and the benefits higher.

What are the actual steps I am suggesting?

1 Begin immediately to **inform the Australian public** of climate measurements, e.g. -

- CO2 levels in our atmosphere and the rate of change.
- Measured temperatures over the last 100 years in Australia and across the world. This should include mean temperatures (averages), maximum and minimum, days over 30 degrees C, new Record Temperatures recorded, and progression of changes, (Graphs).
- Include other indications like coral bleaching, glacier retreat, loss of sea ice, Artic, etc
- Put changes into the context of medium, and long term and geological time frames.

2 Begin **fact-based conversations** led by scientists on Climate Change effects like -

- Likely Impacts on droughts, floods, cyclones, and extreme weather events.
- Climate induced changes to fire risk, frequency, and fire behaviour.
- Raise issues to do with wildlife, species extinction, biodiversity, and habitat loss.
- Use science to explain the likely impacts on farming, fishing, and food production.
- Use figures and projections to engage people with marine impacts of climate change.
- Discuss the drivers of sea-level change and what the range of expectations are.
- Show Australia's and Global CO2 emissions in relation to atmospheric CO2.
- Use Australian scientists to explain time delays, feedback loops and how CO2 is removed from the atmosphere and the time required to remove it.

3 Rapidly begin large scale electricity **generation with renewable sources** (solar/ and wind). This will be much more effective when combined with storage and grid upgrades.

4 Begin a program of **energy storage** with a range of systems but mainly batteries and pumped hydro. The initial aim is to stabilise the grid, to provide short term storage to reduce the impact of renewables intermittency and eliminate Peaker plants by adding lots of cheaper, cleaner, solar, wind and storage. Also, upgrade the grid to move power to where it is needed.

5 Remove all government subsidies on fossil fuels and land clearing to promote change.

6 Replace these with subsidies on **grid scale and domestic Solar PV** and heating and efficient heat pumps. Subsidise domestic and grid scale battery storage.

7 Promote CO2 free nuclear energy (LFTR) and install some SMR capacity, ASAP.

8 Try to engage in **partnerships, joint ventures**, and other mechanisms to engage Australian science and business in all levels of manufacturing, research, and development to promote more rapid and integrated adoption of low carbon manufacturing and job creation.

9 Use tax laws and government incentives plus infrastructure roll outs (e.g., charging stations) to promote the rapid uptake and fleet replacement with **electric powered vehicles**. Aim for electrification of 20% of all transport within 10 years and over 80% before 2050.

10 Introduce a **Carbon tax** on all fossil fuels based on their CO2 emissions. This should be at the mine, Gas plant or point of import. It should have **zero exemptions** or offsets. The rate should be set (and maintained) to deliver a nominated return (say 2 billion dollars). 100%

of these funds should be used to promote low carbon energy and transition costs. These funds should be divided into several separate pots such as, A. Infrastructure B. Science and Education C. Transport D. Adaption E. Environment. Clearly, we will need additional funds to achieve these objectives. The aim is to promote change, not to fund it.

11 We should begin to **wind back production of fossil fuels** for export. Clearly, Australia gains a lot of revenue and jobs from the export of Thermal coal and gas. We have competing industries such as tourism and farming that are being badly and permanently damaged by climate change. Further, the costs of sea level rise, heat waves, increased fires and droughts and extreme weather will become intolerable in coming decades. Climate Change (global warming) will be so locked in that the current 1.5 to 2 degrees will soon be replaced by over 3 degrees of warming and these changes will take many centuries to reverse.

We have been able to live without these new fossil fuel projects (and the income they generate) up until now, so we can continue to do without these short-term gains of a resource boom from non-renewable energy projects. It means we can get more long-term sustainable jobs from renewable energy, supported by baseload nuclear generation. This is not possible overnight, but it must become a priority. Selling our future for short term profits in exchange for large, very long-term, reductions in our standard of living, global disruption, and the loss of national treasures like the Great Barrier Reef or our unique wildlife is an insane deal.

Making a few companies or individuals extremely rich while the rest of us (and all future generations) suffer massive disadvantage should be unacceptable. Three degrees of warming will make the Corona Virus and 2020 look like the good old days except there will be no chance of a vaccine to eventually make it go away.

12 Every opportunity to reduce human induced Climate Change must be considered. There are plenty of other serious issues that will need to be managed over the coming years. We must **not fail to take effective Climate action, ASAP.** Every day of delays means we are at greater risk of simply being overwhelmed. We cannot blame others when we are among the worst on the planet on a per capita basis. We cannot accept creative accounting in place of effective action. We must not pretend that this will only be a problem for our kids and grandkids. In 20 years, we could have passed the ***'point of no return'***. Once you go over the cliff, most people are going to wish we put the brakes on sooner, but the laws of gravity do not care what we would like. Physics is about what is going to happen while politics may try to convince people it is all going to be fine. Sadly, Physics will win that fight every time.

13 The last four years in the USA have provided us with a clear illustration of the limits of political power and how many people's health, freedom, and personal fortunes can be adversely impacted by a few people who do not understand or accept science or are willing to sacrifice truth and the greater good for their own personal power and wealth. We **must let science (not politics and social media) guide us**. Failure to do so should bring disgrace. Climate Change deniers are betting that they will not be held personally responsible and are happy to sell your children's future for their own short-term gain. Australia's inaction and poor response is used by other countries to justify their own inadequate responses.

14 Right now we have dozens of things that can help lower Australia's emissions, provide more long-term jobs, and make Australia a positive force to limit CO2. We must **use**

the profit motive to re-engineer our electrical systems and decarbonise our economy. Renewables are cheaper, cleaner and will be available forever. Electric powered transport and industry is already better and improving rapidly. Instead of letting fossil fuels get a free ride by not having to pay anything for the pollution and CO2 emissions they cause, we should put a price on fossil fuels (based on their emissions) and use those funds to speed up the transformation of our energy economy. Winning easy battles but losing this war is losing everything. Any major change offers potential advantages if we are smart enough to seize them and some short-term pain which will not be uniform. It has always been so for any worthwhile change and we must find the courage to do what is needed, even if some people complain. Is it worthwhile to at least try to treat the cancer once we know it is there?

15 Use our cheap, low carbon energy to transform and upgrade our industrial energy use. Australia can use our resources plus renewable energy to make us an industrial powerhouse or we can be a mine for China and no longer be the 'lucky country'.

16 Supporting changes and those who are disadvantaged in the rapid adjustments needed is much smarter than not acting and therefore disadvantaging everyone, forever. Blaming large emitters (like India) is nonsense. They emit much less Greenhouse gases per capita than we do. Forget others and get our own house in order and lead by example and trust that others will too. Contribute to the IPCC and international bodies, but fix our own emissions, ASAP.

If you are serious about energy storage, you must get started straight away. If it is 30% cheaper in 5 to 10 years, that is a bonus for then, and one we can benefit from then as we will still need to be adding more storage for many years. We need to start now to drive prices down and reduce emissions. South Australia has already reached 50% renewables. Part of this is from the Hornsdale Power Reserve which provides almost 200MWh of storage and saves the state significant funds. The battery, which cost about **$90.6 million** AUD, generates a revenue of **$13.1 million** (11.8% return on investment). Black-out reductions and grid stabilisation benefits are estimated to have, **'saved** South Australian consumers over **$150 million, in its first two years of operation.**' Remember, it only cost about **$90.6 million** AUD. I think that is a good deal, right now. Batteries and pumped hydro will get even cheaper. We can't wait, and delays are economic vandalism. You get an excellent return, improve sustainability, and emit less CO2, right now. These type of savings and lifestyle improvements are the result of acting to save the planet, not acting to save a few dollars. If we were really smart, **we could build our own lithium batteries and solar panels**.

There is so much we can do cheaply and easily but we need to get cracking. Any target of less than a 50% CO2 reduction in the next ten years will be inadequate to protect our future, our country, our lifestyle, the environment, and jobs, and those of our kids and all Australians and future generations, or to begin to redress our exceedingly high CO2 emissions per capita. Why pay for fossil fuel when we can get the same result with free, sustainable, sun and wind and not have to risk everything. Zero CO2 renewables can help protect our future and that of our children and grandchildren. We have wasted the last 30 years. If we waste the next 30 years, Runaway Climate Change will be locked in.

Assuming you have understood the science, and can understand the climate measurements, Climate models and projections of climate scientists and the IPCC, this is **a simple 'Cost/ Benefit Analysis'**. Is it cheaper to act now or later? Should we look at just the three-year election cycle or the 28 years to 2050 or 200 years? If we fail to act, when will we pass a point of no-return where the CO2 in the atmosphere and positive feed-back loops mean that we can no longer take any action that could prevent out of control Climate Change.

How much will these things cost if we do nothing? - You decide, for you and Australia.

- 500 mm of sea level rise or 2,500 mm of rise (2.5m is half the rise in the PETM)
- Greatly increased fires and floods and droughts and Cyclones (almost every year).
- The loss of the Great Barrier Reef and other coral reefs (due to frequent bleaching).
- 10 to 20% reduction in productivity of our farms and marine resources, forever.
- Extinction of over 20% of all our plant and animal species in the next 100 years.
- Doubling of the number of heatwave days over 30 degrees C, before 2050.
- Runaway CO2 and Methane release (positive feedback loops) in the Artic.
- 500 million climate refugees worldwide, all searching for somewhere to live.
- Frequent International conflicts to keep borders closed or to gain scarce resources.
- Massive slowing of global ocean currents altering every weather patten on earth.

All the above and much more are likely if we get above three degrees of warming (and some much sooner than that). We have the tools and knowledge to reduce our CO2 emissions. Australia cannot do this alone but if we fail to act, why should we expect anyone else to ever do what we will not, or treat us with any respect, in world forums. We will know we are doing enough when our per Capita emissions are much lower than the world average. Until we reach that point, we should just do everything we can to lower our emissions and maximise our natural advantages and be a good medium power and decent neighbour. Providing cover (excuses and justification), for larger emitters must not be our legacy.

I appreciate that 27 pages is far larger than is ideal. It is a big subject, but the solutions are simple. If solutions to help avoid the likely losses we will suffer if even half the likely impacts of Climate Change the scientists and ICCC are warning us about happen, are not worth 27 pages and a bit of effort, then we are in real trouble. These proven solutions can take us most of the way before 2050. They are proven, not difficult, and not even particularly expensive or disruptive for most people. If we make these changes, we have a real shot of having a higher standard of living than now and a decent future for all future generations of Australians. We just need the time, and the courage to act now.

Gary Nahrung

Re Australian Energy Market Commission draft determination.

Feed-in tariffs to be reduced 25.3.2021

I would like to Submit a written rule change request

- **The name and address of the person making the request**

From - Gary Nahrung –

306 Redland Bay Road, Thornlands, QLD, 4164.

32077704 0438830196 (mob.) garynahrung@gmail.com

- **a description of the rule that the proponent proposes be made -**

Feed-in tariffs should not be reduced as proposed. Auto bidder type software should be offered as part of any domestic battery installation (usually, but not always related to rooftop solar). Storage (initially from grid scale and domestic batteries, then also from pumped hydro) should be installed in every State, ASAP. Australia should aim for a rapid switch to renewables and away from all forms of Fossil Fuel Energy.

Description -

I believe that further reducing the feed-in tariffs is a very poor idea and counter-productive to what should be our aim, of rapidly increasing the percentage of renewable (solar) generation capacity, (both domestic and grid scale). Further, the main reason for reducing the feed-in tariff would seem to be that the renewable electrical energy being generated by rooftop solar is not needed in periods where supply (by fossil fuel generation plus solar), exceeds demand. A far fairer way to deal with this situation is to continue to purchase solar electricity that is surplus to immediate demand and use it to recharge batteries or fill pumped hydro storage for use in peak demand periods. This supports Australia's need to reduce our CO2 emissions by not inhibiting renewables to favor non-renewables. It keeps average energy price lower, helps supply peak demands, and treats domestic customers fairly.

The very generous feed-in tariffs that helped Australia get 20% of homes with Solar are now less important, as Solar is now a proven technology. There should be a standard tariff for all rooftop solar feed-in (guaranteed), which should be higher for people who have installed a reasonable size battery storage the grid can access, or they should be linked with auto-bidder software so they can elect to be paid at commercial rates (both higher and lower, with a capped upper and lower price), if they choose to buy from the grid or sell during higher priced, undersupply. Australians deserve a power system that is not among the dirtiest in the world and a future where Climate Change is treated seriously.

Home owners should not be treated as a convenient buffer to support fossil fuel generators. Domestic customers with rooftop solar, should not be charged for the privilege of exporting their excess energy back into the grid while conventional generators continue to be paid for their excess generation. Various Governments, both State and Federal, have failed to install anywhere near enough electricity storage to allow renewables to be integrated into the grid. Clearly, without the massive contribution of domestic solar (rooftop solar panels), Australia would be further behind meeting our international commitments to reduce CO2. These commitments are already wholly inadequate by world standards, and by what is needed

The AEMC (Australian Energy Market Commission), should promote Grid scale batteries such as was built at Hornsdale, South Australia, and are currently being constructed in Victoria and New South Wales. They should also move to promote and construct at least one multi-gigawatt Pumped Hydro storage in each State. This will ensure we support cheaper, cleaner, very low CO2 renewables and *"don't leave anyone behind because every Australian, whether they have solar or not, deserves an affordable, sustainable power system".*

This should include all those people who have purchased domestic rooftop solar with the expectation of receiving a feed-in tariff. This supports their desire to contribute to lowering CO2, and helps demonstrate they made a sensible choice. They should not be made second class to polluting Fossil Fuel generators (who should also be paid, but also at a lower rate) for their oversupply. If clean CO2 free Solar generators are not paid, neither should dirty, polluting, expensive fossil fuel generators. Clearly, if you want fairness, you need storage (Batteries and pumped hydro). With storage, feed-in electricity will always cost less than the price it will be resold. Feed-in tariffs help build stakeholder awareness and understanding.

If we install more storage every year, we can all benefit from the lower cost and zero CO2 of renewables. Grid batteries provide a valuable use for electricity in low demand (recharge). The solution is not to cut feed-in tariffs, but to install batteries (see - Hornsdale example) Grid scale batteries are effective, cost effective and saves money and supports domestic solar.

- **a statement of the nature and scope of the issue concerning the existing rules that is to be addressed by the proposed rule change request and an explanation of how the proposed rule change request would address the issue**

Australians love Solar energy, and we currently have around 20% of homes supported by solar energy. This will double over the next ten years and would be even better if storage was available to fully utilise energy at periods of low demand or high generation. The most efficient way to do this is not home batteries but grid scale storage, like what was constructed at Hornsdale, South Australia. This battery farm provides almost 200MWh of storage. The initial 129MWh, was installed in just 67 days from the signing of the contract with Tesla Inc., but it has already been increased to around 200MWh of storage. The battery, which cost about **$90.6 million** AUD, generates a revenue of **$13.1 million per year** (11.8% return on investment). Black-out reductions and grid stabilisation benefits are estimated to have **'saved'** South Australian consumers, over **$150 million, in its first two years of operation.**

The levelized Cost of Electricity (a standard comparing cost of generating Electricity) shows that Utility Scale Solar and Wind are already the cheapest forms of generation. They are both much cheaper than Coal, and Peaker plants and are cheaper than Gas Combined Cycle (the cheapest conventional generation option), and they produce zero CO2 during use.

Levelized Cost of Electricity (LCOE) Generation. Emissions quoted as **kg/ MWh CO_2, not CO2e**

Source (estimates by Lazard)	Typical LOCE $/MWh (2019)	Mean of price Range - Per MWh	**CO_2 emissions** Typical **kg/MWh**
Wind (onshore)	29 to 56	42.5	0
Solar PV (Grid scale)	36 to 46	41	0
Nuclear (current PW reactor)	112 to 189	150.5	0
Hard Coal generation	60 to 143	101.5	414
Natural Gas *Combined Cycle*	*41 to 74*	*57.5*	227

No home generator should be treated worse for generating clean, CO2 free, electricity by new rule changes by the AEMC and no new home installation should be excluded from receiving feed-in tariffs. Clearly it is in the long-term interest of consumers to maximise the use of cheap, clean renewables and to rapidly reduce the dirtiest non-renewable options of Coal, Oil and Gas Peaker plants. The Levelized Cost of Electricity (LCOE) Generation for renewables plus four hours storage is already cheaper for Solar than for gas and miles cheaper than the obsolete coal, oil, and Peaker supply. If the non-renewable fossil Fuel Generators were required to pay for the damage their pollution and Climate Change is causing, they would all be much more expensive, than wind and solar with ample storage.

NSW is getting a 50MW Tesla Megapack Battery, at a cost of $65M, to return $93 – $135m of savings. The Wallgrove Grid Battery project will trial the use of a 50MW/75MWh lithium-ion battery to provide fast frequency response and synthetic inertia services to the NSW transmission network.

Victoria - Total Eren, a partnership between Total, one of the world's fossil fuel majors and renewable energy company EREN RE, has recently announced a 200 MW Kiamal solar farm project in Victoria, Australia, and an enormous **Battery Energy Storage System** (BESS). The local authorities, Mildura council, have approved a 100 MW/380 MWh storage facility.

- **an explanation of how the proposed rule change request will or is likely to contribute to the achievement of the relevant energy objective**

In their explanations (or justification) of this proposal, the AEMC (Australian Energy Market Commission) refers to this situation as 'traffic jams' and not as periods of oversupply (which is what it really is). The way to solve traffic jams is to remove choke points or bottle-necks to allow all traffic to use the road freely and equally, when they need to. In electrical grid terms, this means that adequate storage needs to be included to deal with the periods of high and low demand and to take full advantage of cheaper, cleaner renewable energy.

The issue is storage and there are two excellent, proven candidates to meet Australia's needs. Grid scale batteries and pumped hydro. While we need both, it is batteries that are quickest to install and more efficient and flexible. They could quickly address the problem of oversupply, and help stabilize the grid. I am 100% in favor of distributed power networks, solar, home storage, and auto bidder energy markets to promote renewables. There are two fundamental truths that we should acknowledge. **1** Grid scale Solar and Wind generation and Grid scale storage are much cheaper because of economies of scale than domestic versions of these services. **2** Transportation, Industry, Commercial and Residential, and Agricultural energy demands, combined represent far more energy demands (and produce far more Greenhouse Gas emissions), than does current electrical generation. Since rooftop solar is only a minor part of all energy used, this is fiddling at the edges. Worse, it is being portrayed as a significant step forward. Rooftop Solar is an excellent, (but very minor) component of what is needed. These proposed rule changes will slow domestic solar uptake.

What is needed is a comprehensive plan to halve our CO2 emissions over the next ten years. These changes deliver no more than a few percent at best. I have attached a much more comprehensive discussion of how we could easily combine proven existing renewable generation, storage, and distribution technologies to halve our CO2 emissions (in ten years), improve sustainability and improve our energy independence, quality of life, get more jobs and improve our international standing. While the primary driver for these changes (for me and for Australia) should be reduced CO2 emissions (and all Greenhouse Gas emissions), switching to renewables will result in cheaper. cleaner, reliable energy across all sectors.

Since 1995 to our projected emissions position in 2030, Australia will not reduce its total annual emissions of CO2 at all (not even a single tonne per year reduction, in over 26 years), when we now know the need for reductions. Without adequate storage, we will never fully convert to zero fuel inputs, zero operating emissions, and cleaner, cheaper renewables.

How much better for Australia if we remained reasonably generous on feed in tariffs (because we have built sufficient energy storage) and pay a modest price for any feed-in supply (even if demand is low) and offered significant feed-in bonus returns for high demand periods (supports batteries), particularly from domestic storage. This could be far more effective at supporting rooftop solar and add several more percent to our desired objectives and would help reduce the average price of our electricity and improve grid stability.

- **an explanation of the expected potential impacts of the proposed change to the rules on those likely to be affected including costs and benefits.**

The Levelized Cost of Electricity (LCOE) Generation for renewables plus four hours storage is already cheaper for Solar than for gas and much cheaper than obsolete coal and oil generation. This situation will increase over the next decade and the AEMC should not be trying to slow renewables down, but rather provide clear rules, and support that favor renewables, not protect fossil fuel. Further, the AECM (or some semi-autonomous Government organization) should directly participate in renewable generation and distribution (poles and wires), so all Australian's benefit and cannot be held to ransom by large companies and overseas investors. Distribution (poles and wires), should not be used to limit the adoption of rooftop solar, or commercial (grid scale) solar generation, and if it ever is, this needs to be rectified.

Switching to almost 100% renewables before 2050 will massively reduce energy prices, improve our long-term sustainability, reduce our dependance on foreign oil, increase jobs, decrease pollution, lower costs for industry, transport, commercial and residential, and agriculture, and slash CO2 emissions and so support global efforts to reduce Climate Change.

- **In the case of a rule change request from an energy regulatory body that could be a "fast tracked" rule, a summary of the consultation conducted by the energy regulatory body is required.**

I am not an energy regulatory body.

Regards,

Gary Nahrung

043 883 0196 32077704 garynahrung@gmail.com

<u>Your Position</u> - "***We can decarbonise the electricity sector faster and cheaper if we connect more small solar customers and make it worthwhile for them to install batteries.***" AEMC Chief Executive Benn Barr said. "*But to do that, we need to make some changes to the power system".*

"Within 10 years, half of all energy users will be using home energy options like solar. We must make sure this seismic shift doesn't leave anyone behind because every Australian, whether they have solar or not, deserves an affordable, sustainable power system."

My Position -

I would be delighted to discuss these issues or to participate in formulating better policies that support Solar, and Australia's need to rapidly reduce CO2 emissions.

I look forward to an opportunity to discuss my proposal, ASAP, as per your offer that '*AEMC staff are also available to assist proponents in developing their proposal'*.

The Levelized Cost of Electricity (LCOE) Generation for renewables plus four hours storage is already cheaper for Solar than for gas and miles cheaper than the obsolete coal, oil, and Peaker generation options.

Further, renewable energy is sustainable, essentially forever. Non-renewables must run out, eventually. In the meantime, Australia is almost the world's highest, per Capita emitter, of Climate Changing CO2 in the world, and Australia is among the most susceptible of all countries to the impacts of human induced Climate Change.

Clearly it is in the long-term interest of consumers to maximise the use of cheap, clean renewables and to rapidly reduce the dirtiest, more expensive non-renewable options of Coal, Oil and Gas Peaker plants.

If we install more storage every year, we can all benefit from the lower cost and zero CO2 of renewables. Grid batteries provide a valuable use for electricity in low demand (recharging storage). Lithium-ion batteries provide fast frequency response and synthetic inertia services as well as convenient storage and peak demand support.

The solution is not to cut feed-in tariffs, but to install batteries (see - Hornsdale example) Grid scale batteries are cost effective, help stabilise the grid (reduce traffic jams), and save the taxpayer money. They support domestic solar as well as grid scale renewables.

Since 1995 to our projected emissions position in 2030, Australia will not reduce its total annual emissions of CO2 at all (not even a single tonne per year of reduction in over 26 years), when we now know the need for reductions. Without adequate storage, we will never fully convert to zero fuel inputs, zero operating emissions, and cleaner, cheaper renewables.

I fully accept that the AEMC is somewhat hamstrung by absurdly short-sighted Government policy and a stated primary objective of price control (not low CO2 as it should be). The truth is that renewables are already cheaper than coal, oil and Peaker generation and if fossil fuels were required to pay even a small amount for their pollution and CO2 and methane fugitive emissions, they would also be **much** cheaper than Natural Gas. The Levelized Cost of Electricity (LCOE) Generation for renewables plus four hours storage is already cheaper for Solar than for gas (even with no pollution tax).

I look forward to your response to this submission.

Gary Nahrung